China’s Dryland Farming and Practices

Zhu Yu, Deputy Division Director
Department of Crop Production, Ministry of Agriculture, P.R. China

Dryland farming refers to high-yield and high-efficient agricultural production in areas without irrigation capability and mainly depending on natural rainfall through the adoption of a set of dryland farming practices.

China’s farmland water resource per mu is only half of the world’s average. However, dryland accounts for the majority of farmland. Flood, waterlogging and drought are the main restraints in China’s agricultural production. In fact, losses caused by drought are much severer than that by flood. Drought affected area in the 1950s was 200 million mu and 300 million mu in the 1960s and 1970s; in the 1980s and 1990s the area continued to expand and seriously affected area and losses caused by drought have become the severest of all losses caused by natural disasters. Experts estimate that flood caused loss in the 1990s averages 10 billion US dollars per year, while that by drought reaches over 35 billion US dollars. Given the severe shortage in China’s water resource, irrigation alone can not satisfy the water demand in agricultural production. Thus, it is important to make great efforts in promoting dryland farming development while strengthening the development of farm infrastructure focusing on water conservancy works.

1. China’s present situation of dryland farming development

Dryland accounts for above 70% of total farmland in China, found mainly in Northeast China, North China, Loess Plateau and Northwest China dryland area, which accounts for over 70% of China’s total dryland.

Dryland farming area in China is widely located, including the vast rainfed area to the north of Qinling Mountain and Huaihe River where precipitation is not sufficient and the seasonal arid hilly area in the upper and middle reaches of the Yangtse River where precipitation is sufficient but water conservancy facilities are rather backward. It mainly covers about 1000 counties in over 20 provinces (autonomous regions or municipalities). The total dryland area reaches more than 1 billion mu, among which there are above 0.4 billion mu of hilly slope dryland with an angle below 25 degrees. Among these dryland areas we can find both China’s important production bases of grain, cash crops and animal products and less developed areas, ethnic areas and areas with middle and low yield.

There are three outstanding problems in China’s dryland farming. First, shortages in precipitation, surface water and ground water. Water resource per mu in northern dryland area is only 1/5 of China’s average. Precipitation declines from southeast to northwest from 700 mm to below 250 mm and is distributed unevenly in time and space. Usually, spring rainfall represents 10-20% of the year total, summer rainfall over 40%, autumn rainfall 20-30%, winter rainfall below 10%. Due to insufficient precipitation, the water volume in rivers here is only 20% of the national total. At the same time, water loss and waste in farmland irrigation are serious. Ditch water utilization rate is only 40-50% in general, while that of some places is as low as 30%. Water use per mu in some places is 700 m^3 while in a few cases it is even higher than 1100 m^3.

Second, infertility of soil. In the Loess Plateau area, good-quality farmland is only about 21%, low-quality farmland above 48% and some farmland is too poor to be farmed.

Third, monotonous crop structure. More cereal crops and less legume crops are planted. Cash crops made very slow progress in most places.

Fourth, degradating ecological environment. Dersertificated land and eroded land are mainly found in the dryland farming area. In the recent 15 years, dersertificated area increased by 1700 km^2 per year in average. Eroded area has reached 3.67 million km^2 accounting for 38% of the total national territory, among which water eroded area is 1.79 million km^2 and wind eroded area is 1.88 million km^2. 60% of silt in the Yangtse River Valley comes from the slope farmland in its middle and upper reaches. Silt rushing into the Yangtse River from Sichuan and Chongqing reaches more than 500 million tons a year and silt rushing into the Yellow River from Shaanxi Province alone per year is above 500 million tons. Soil erosion leads to soil loss of 5 billion tons per year. Increasing sandy soil in the north and stony soil in the south have led to a decrease of over 1 million mu of farmland annually. In some places, owing to the vicious cycle of poverty, excessive land reclamation and soil erosion, the eco-system has been devastated, resulting in more frequent natural disasters such as flood, drought and sandstorm.

Fifth, low and unstable agricultural yield. According to statistics, in 1993 yield per mu in about 1000 counties in drought affected area in the north was 240 kg, 30 kg lower than the national average. Presently, grain yield per mu in some places is even less than 50 kg. In addition to poverty, farmers in the vast drought affected areas are suffering from several other factors, such as poor level of skill and education and socio-economic situation. They practise extensive farming with poor harvest. In some places, farmers still solely depend on climatic conditions in their farming activities.

It is of great significance to accelerate China's dryland farming development. First, it will promote the phasing out of farming activities from farmland and restore it to forest, pasture and grassland. For example, in Hubei province, broader application of dryland yield increasing technologies, such as corn mulching, will withdraw over 1.2 million mu of slope farmland with an angle above 25 degrees from farming. Second, it will decrease soil erosion area and gradually better the eco-environment in the Yangtse River Valley and Yellow River Valley. Through developing dryland farming, we will plant trees on hills, build terraces half way up the hills and grow grass at the foot of hills so as to maintain soil moisture, fix and fertilize the soil and effectively prevent soil erosion. Third, it will increase grain yield and speed up the solution of China's food and clothing problems for the poor. Above 2/3 of China's poverty-stricken people live in dryland farming area. It is a fundamental way to solve the food and clothing problems by accelerating dryland farming development and increasing grain yield. At present, each millimeter of natural rainfall can bring about grain yield of about 0.2-0.3 kg in China's dryland area, far behind the developed countries' level (2-2.5 kg) and China's small plot experiment level(0.6-1.2 kg). In recent years, experiences in dryland farming demonstration counties show that grain yield can be increased by over 50% and yield per mm of rainfall by above 0.6 kg. Fourth, it will help to readjust rural industrial structure, rationally locate farmland, forest and grassland and gradually increase farmer's income in order to turn the vast dryland areas into China's major production and processing bases of agricultural and side-line products and make great contribution to the sustainable and stable development of China's agriculture and national economy.

2. Major Measures

The objectives for the development of dryland agriculture are as follows: to enhance moisture retention capacity of the soil and retain rainfall by using agronomic, biological and engineering measures in an integrated way; to improve soil fertility and turn "three-losing land" (soil-, water- and fertilizer-losing land) into "three-conserving land" (soil-, water- and fertilizer-conserving land); to change farming practices and make full use of resources like light, heat, soil, fertilizer, water and improved seeds to increase yield and agricultural productivity in the dryland. Major measures include:

2.1 Terracing

This measure is meant to build slope land with an angel less than 25 degrees into contour terrace. Slope land with an angel of 10-25 degrees is susceptible to soil erosion due to large angel, steep slope, frequent farming activities and high cultivation coefficient, particularly improper farming practices. Investigation results have shown that farming activities on such slope land have each year led to a soil erosion of 0.43 cm of soil layer and loss of 48 tons of surface fertile soil per ha. To change such slope land into contour terrace, plus other measures like small catchment improvement and biological and agronomic practices, will help to improve production conditions, prevent water and soil erosion and raise land quality and grain yield. Slope land with an angel of 6-10 degrees will be improved to plant crops along the contour using trench culture with 1/2 meter deep and 1 meter wide trench or ridge culture featuring three-dimensional farming approaches with improved soil so as to conserve soil and water, improve soil fertility and facilitate sustainable development.

2.2 Furrow Drilling

This measure means to use farming practises like moisture retention mulched furrow, machine furrow drilling and large furrow. The main purpose is to increase active soil layer, improve moisture retention capacity and soil fertility, reduce soil evaporation and improve eco-system. The Yan'an practice has shown that such measure can increase soil moisture retention by 81.87 cubic meters per mu in places with annual rainfall of 197 mm. This technique is suitable for any slope land with annual rainfall over 400 mm, or for terrace land. When it is used for small-angel slope land and terrace land, machines or animals can be employed to reduce labour intensity and speed up engineering progress. Presently, this technology has been used in 10 million mu in northern Shaanxi, southern Shaanxi, eastern Gansu, northern Hebei and northwestern Shanxi, resulting in yield increase of around 40-60%.

2.3 Water cisterns

This measure is meant to build water cisterns to collect rainfall as supplementary irrigation water. In slope land and terrace land, water retention works will be built to collect natural rainfall as supplementary irrigation water for agriculture. In case of serious drought, such water can be used for drip irrigation to increase soil moisture. Due to limited water volume, such technology is usually used together with other water-saving measures like wet sowing, plastic mulching, root-zone drip irrigation, hole irrigation with mulching so as to enhance crop resistance to drought and ensure stable, high yield. It is applicable to places with annual rainfall less than 350 mm. To build one water cistern with a capacity of 50 cubic meters need an investment of around 400 yuan. It can provide supplementary irrigation water for 2 mu of land and ensure a yield per mu of over 300 kg. If used in production of cash crops like water melon, greenhouse vegetable and fruit tree, it will bring about even greater yield increase.

2.4 Mulching

This refers to mulching with plastic film and crop residue. It can reduce moisture evaporation, increase moisture retention capacity of the soil, alleviate the threat of drought and improve water use efficiency. Plastic film can be used for hole sown wheat, rice, film-side sowing, multiple crops using the same mulching, mulched corn field for water collection with very good results. Wheat farming with plastic film represents a major breakthrough in plastic mulching technology, contributing tremendously to the reform of dryland farming practices and increase of wheat yield. Experiments have shown that wheat with plastic film can produce 30% more than conventional wheat drill seeding, increasing yield per mu by 100 kg, net income by over 100 yuan and saving water by 100 cubic meters. Presently, it is being tried and extended in provinces like Hebei, Gansu, Shaanxi, Ningxia, Qinghai, Inner Mongolia and Shandong.

Mulching with crop residue features easily accessible material, low cost, high efficiency, water saving, moisture retention, fertility enhancement, yield increase and no contamination to soil. It can usually improve soil moisture retention rate by 30-50% and increase water supply by 40-80 cubic meters per mu. Plus balanced fertilization technology like nitrogen, phosphate and potash replenishment, it can at least improve yield per mu by 100 kg, representing an effective solution to the problem of dryness and infertile soil in dryland region.

2.5 Coating

It refers to seed coating mainly using drought-resistant agent. The occurance of drought is often unpredictable. Conventional measures can hardly play their role under such circumstances. Drought-resistant chemical agents developed in recent years, like water-retention agent, evaporation suppressant and soil regulator, can bring very good results at low cost when used at a time of drought. For instance, seed coated with water retention agent can improve moisture use efficiency by 0.05-0.17 kg/mm; compared with the control group, wheat seed coated with drought-resistant agent can increase yield by 20%; and if sprayed before the xerothermic wind, it can increase yield by 9.5-18%.

2.6 Fertilization

It refers to the application of chemical fertilizer, organic fertilizer and green fertilizer to improve soil fertility and yield. Besides drought, another factor constraining productivity in dryland farming area is soil infertility. By moisture control through fertilization, we mean that we can improve soil resistance to drought through the improvement of soil fertility. The main ways include: 1. To establish rational and effective dryland farming structure, increase the percentage of legume and green fertilizer crops and combine farming with fertility improvement. The key is to adopt a grain crop and summer green fertilizer rotation system or grain-oilseed-legume rotation system as well as other farming models like grain-legume and grain-grass intercropping and wheat-potato intercropping in order to fully use natural resources like light, heat and water to achieve yield and income increase. 2. To increase fertilizer input by combing organic fertilizer with chemical fertilizer and improve scientific fertilization level. Practices have shown that increased use of chemical fertilizer on dryland can bring about twice as much yield as on irrigated land. Meanwhile, the use of technology like crop residue mulching and quick rotting of crop residue as fertilizer can also increase the application of organic fertilizer and improve the use efficiency of chemical fertilizer.

2.7 Deep Tillage

This refers to mechanized deep ploughing technology. Through deep ploughing by machines, we can break the subarable layer without disturbing surface soil layer so as to improve soil ventilation and rainfall retention capacity. This can not only be used for dryland but also for irrigated land.

2.8 Seed Replacement

This refers to the use of drought-enduring and drought-resistant seeds. To use drought-enduring varieties is the most cost-effective yield increasing technology. At present, most dry areas have their own varieties with good drought resistance. However after such a long time, most varieties have experienced degradation in their performance. And the breeding of new varieties is still lagging behind. It is an urgent need to develop drought-resistant varieties and accelerate the purification and rejuvenation process in order to improve yield level.

2.9 Farming system reform

This refers to the reform of farming system according to local conditions in order to readjust crop structure, avoid flooding and drought and improve income. Experiences from different places in recent years have shown that it is an effective way to improve yield and income in dryland area by grain-grain, grain-cotton, grain-oilseed, grain-vegetable, grain-herb intercropping and rotation of multiple crops. China's Hubei Province adopted plastic mulching for corn field in hilly area and wheat-mulched corn-sweet potato-soybean (vegetable) rotation. Such practices have increased corn yield per unit area and multiple cropping index. It also helped to phase out farming activities on steep slope land with an angel over 25 degrees.

3. Recommendations

China has a rich dryland resources with huge potentials of yield increase. Research results have shown that each millimeter of natural rainfall in dryland can be used to produce 1 kg of winter wheat, 1.6 kg of spring corn, 0.75 kg of millet, 1.6 kg of sweet potato, 0.6 kg of spring wheat and 0.8 kg of potato. Experts estimate that the rational use of resources and integrated use of engineering, biological and agronomic measures can increase grain output by 150-400 billion kg in China's dryland area and at the same time increase livestock production by big margin. To speed up dryland agricultural development in China, we will further intensify the construction of dryland agriculture demonstration counties and through their demonstrative performance bring dryland agriculture in all regions up to a new level. To undertake such a task is by no means easy for China and we need financial and technical support from developed nations like the U.S. and international organizations. We hope that we can obtain assistance in the following areas:

(1) Research on and improvement of drought-enduring and drought-resistant varieties and matching technology for dryland agriculture. Presently, China considers improved drought- and waterlogging-resistant seeds very important to the development of our dryland agriculture. But there is a very limited number of such improved seeds available to the farmers.

(2) To set up demonstration bases for protective farming technology in China through cooperation so that developed countries like the US can demonstrate their protective farming technology and upgrade China's technical capacity in this field.

(3) To conduct technical exchange on dryland farming technology in order to train a backbone team of professionals equipped with advanced dryland farming technology.

(4) To jointly develop a group of farm tools and machines suited for dryland agriculture in China.

(5) To provide financial resources to support the extension of advanced dryland farming technology in the poor areas of China.

To develop dryland agriculture is a major strategic policy for sustainable agricultural development in China and also a major measure for China’ s agricultural development towards the 21st century. Let us join hands to make our due contribution to the development of dryland agriculture and agriculture in general in the world.